A COMPARISON OF RADIO FREQUENCY INTERFERENCE WITHIN AND OUTSIDE OF ALLOCATED PASSIVE EARTH EXPLORATION BANDS AT 10.65 GHZ AND 18.7 GHZ USING THE GPM MICROWAVE IMAGER AND WINDSAT

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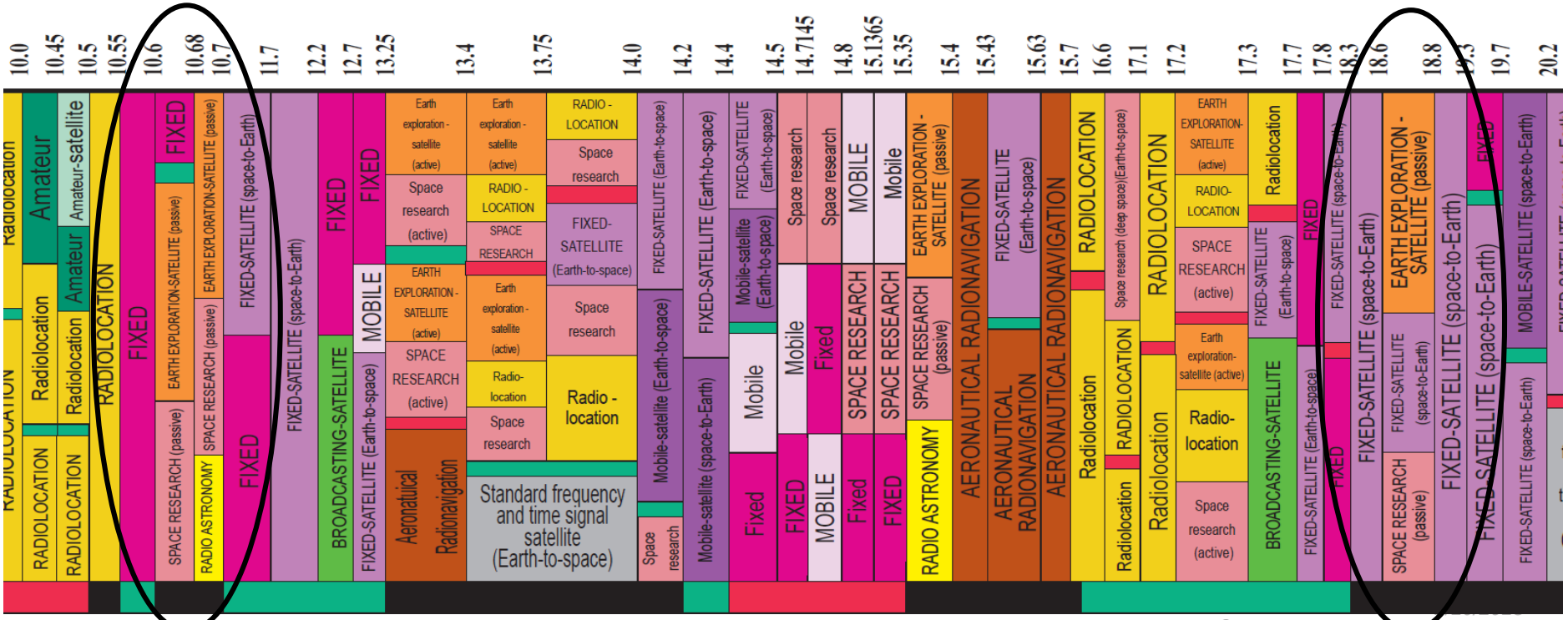
Overview

- Radio Frequency Interference (RFI) for Microwave Imagers has been increasing over time for
  - L-band
  - C-Band
  - X-Band
  - Ku-Band
- The GPM constellation of radiometers provides a unique dataset that we can use to survey the RFI environment

Spectral Allocations for Imager Bands

- NTIA Spectral Allocations are shown below
  - 10.6 to 10.7 GHz band is shared with “FIXED” (i.e. ground) transmitters
  - 10.7 GHz neighbors “Fixed Satellite” (space to earth)
  - 18.6 to 18.8 GHz band is shared with “Fixed Satellite” (space to earth)
- These allocations suggest that the 10 and 18 GHz channels should expect corruption in the earth and cold views



Radiometer Bands at C, X, and Ku

- Green = Within Allocated Bands
- Yellow = Outside Allocated Bands

Instrument	C-Band Center Freq (GHz)	C-Band BandPass (MHz)	X-Band Center Freq (GHz)	X-Band BandPass (MHz)	Ku-Band Center Freq (GHz)	Ku-Band Bandpass (MHz)
GMI	N/A	N/A	10.65	100	18.7	200
TMI	N/A	N/A	10.65	100	19.35	500
WindSat	6.8	125	10.7	300	18.7	750
AMSR2	6.9 7.3	350 350	10.65	100	18.7	200
SSMIS	N/A	N/A	N/A	N/A	19.35	400

Analysis Methodology

- Several RFI identification algorithms have been published, including
  - Model Difference Method: Compares channel of interest to RTM result. Model result can be approximated by a linear combination of other channels (and their squares)
  - Spectral Difference Method: Compares channel of interest to spectral neighbor
  - Principle Component Method: Uses spectral variation information contained in principle components to identify RFI
- These methods can be generalized to be written as a linear combination of channels

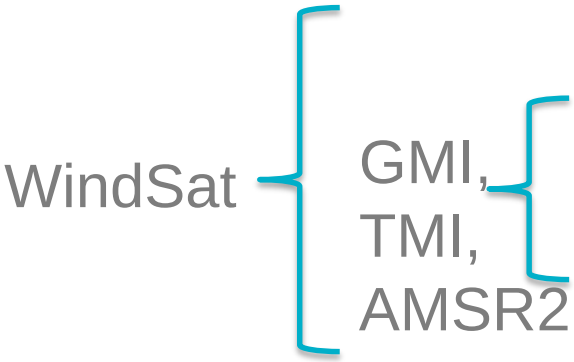
$$\Delta Tb[i] = a'_o[i] + \sum_j \left(a'_j[i] Tb[j] + b'_j[i] Tb^2[j] \right) \qquad (1)$$

where i represents the channel index of the channel of interest, j is summed over all channels, $a'_j[i]=1$ for the channel of interest, $a'_j[i]=b'_j[i]=0$ for channels with the same center frequency of the channels of interest.

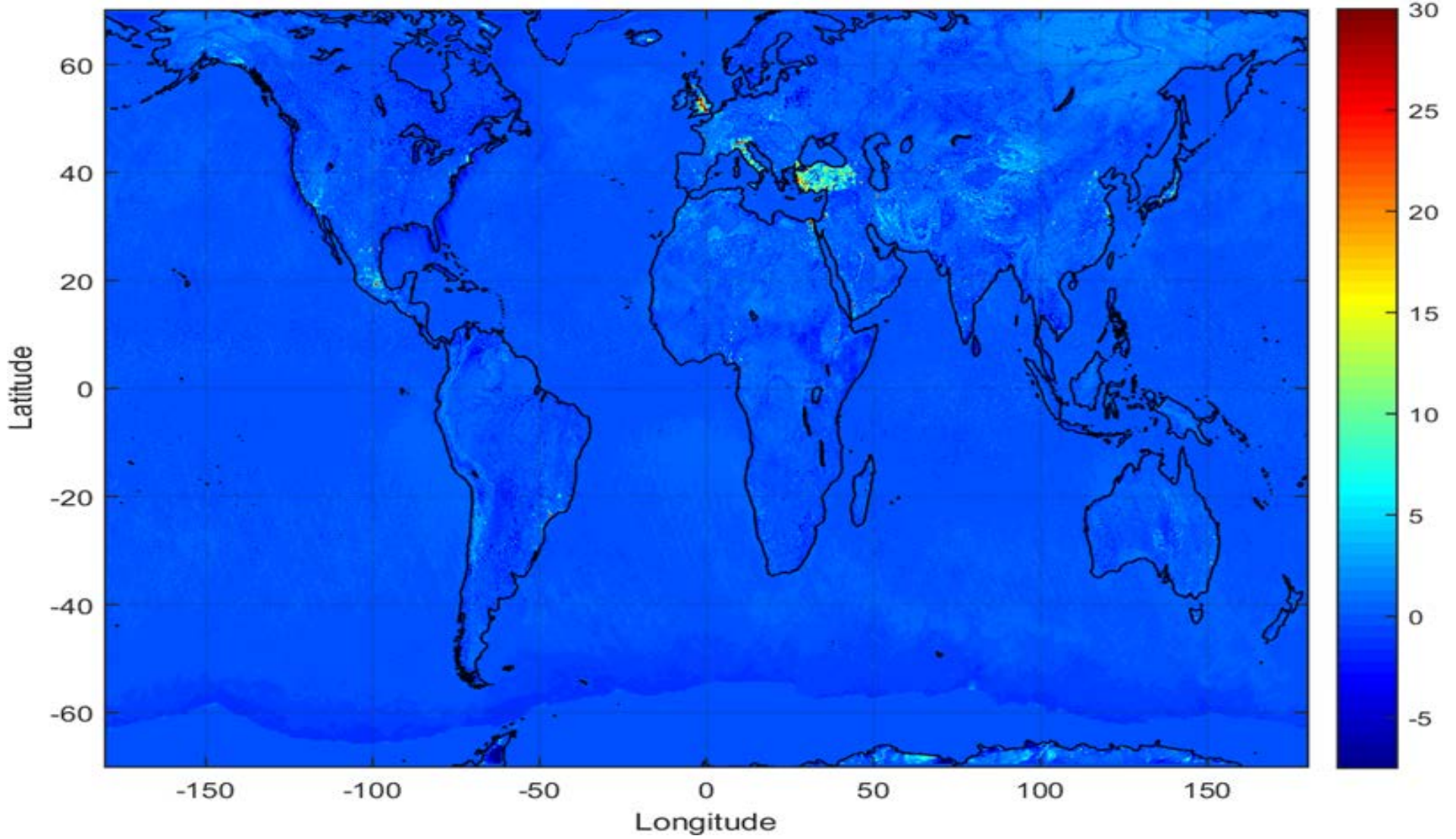
- A separate set of coefficients is determined for land, ocean and sea ice

10 GHZ RFI

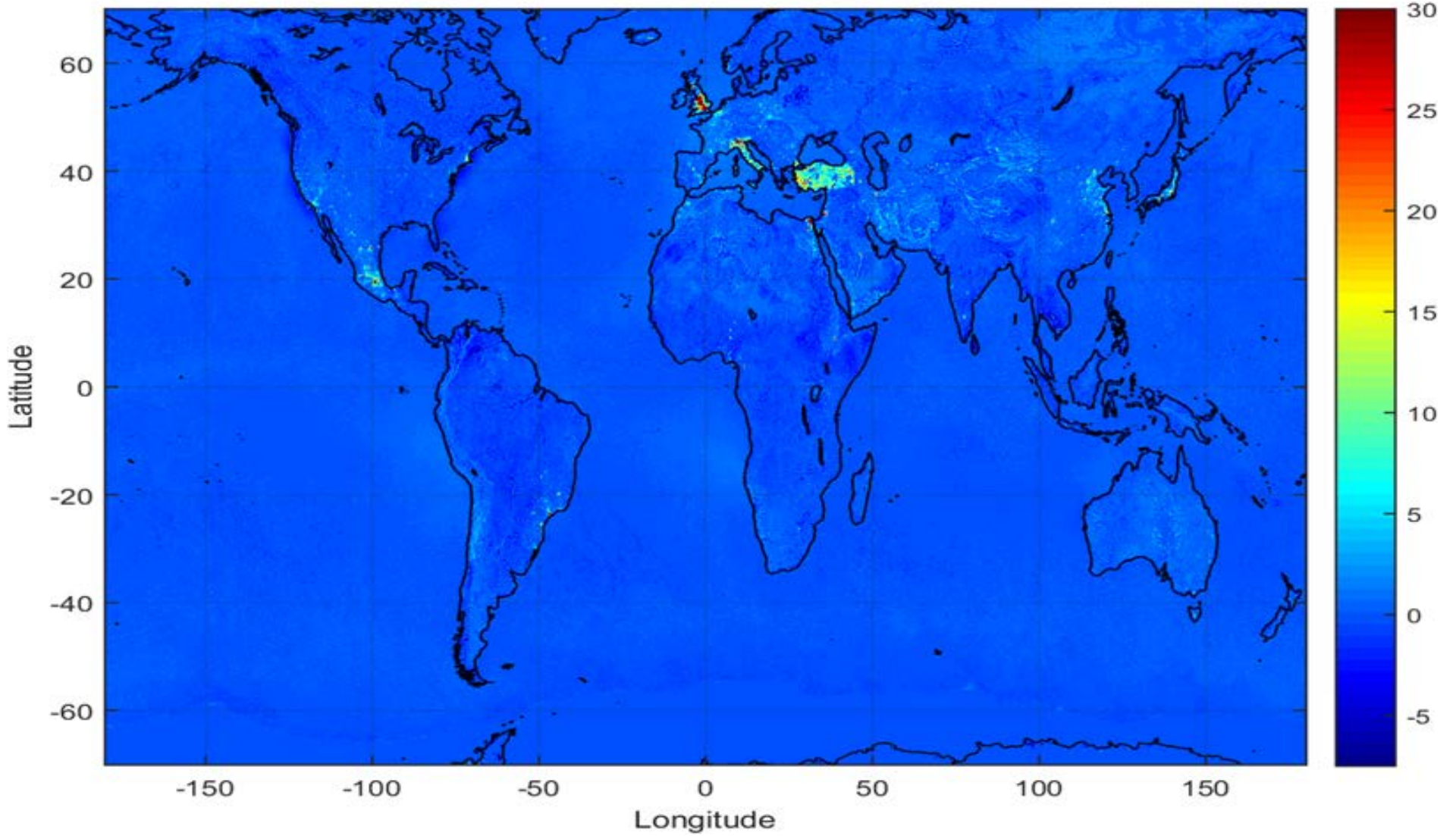
10 GHz GMI and WindSat bands



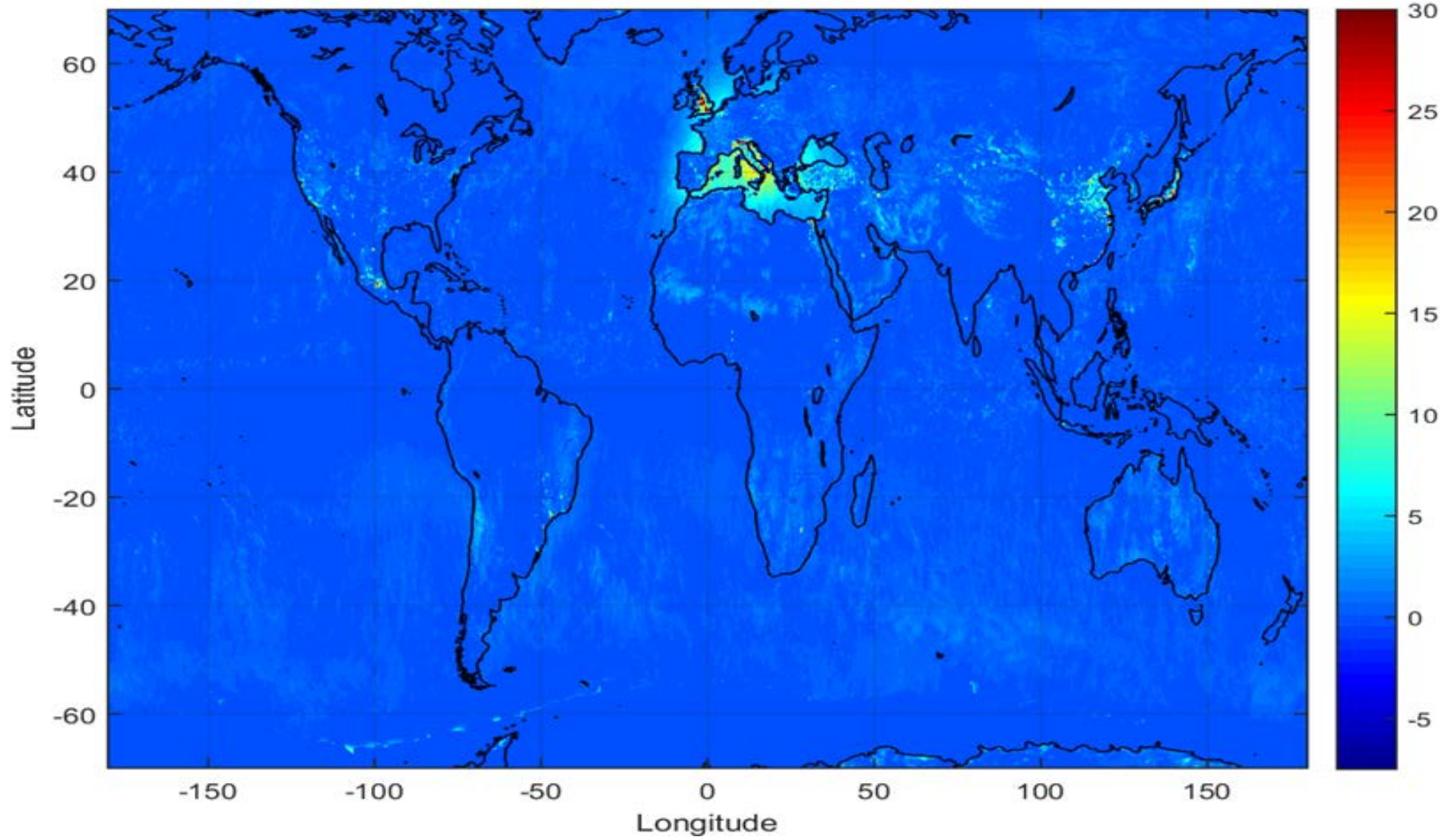
GMI RFI October 2014 10.65 GHz



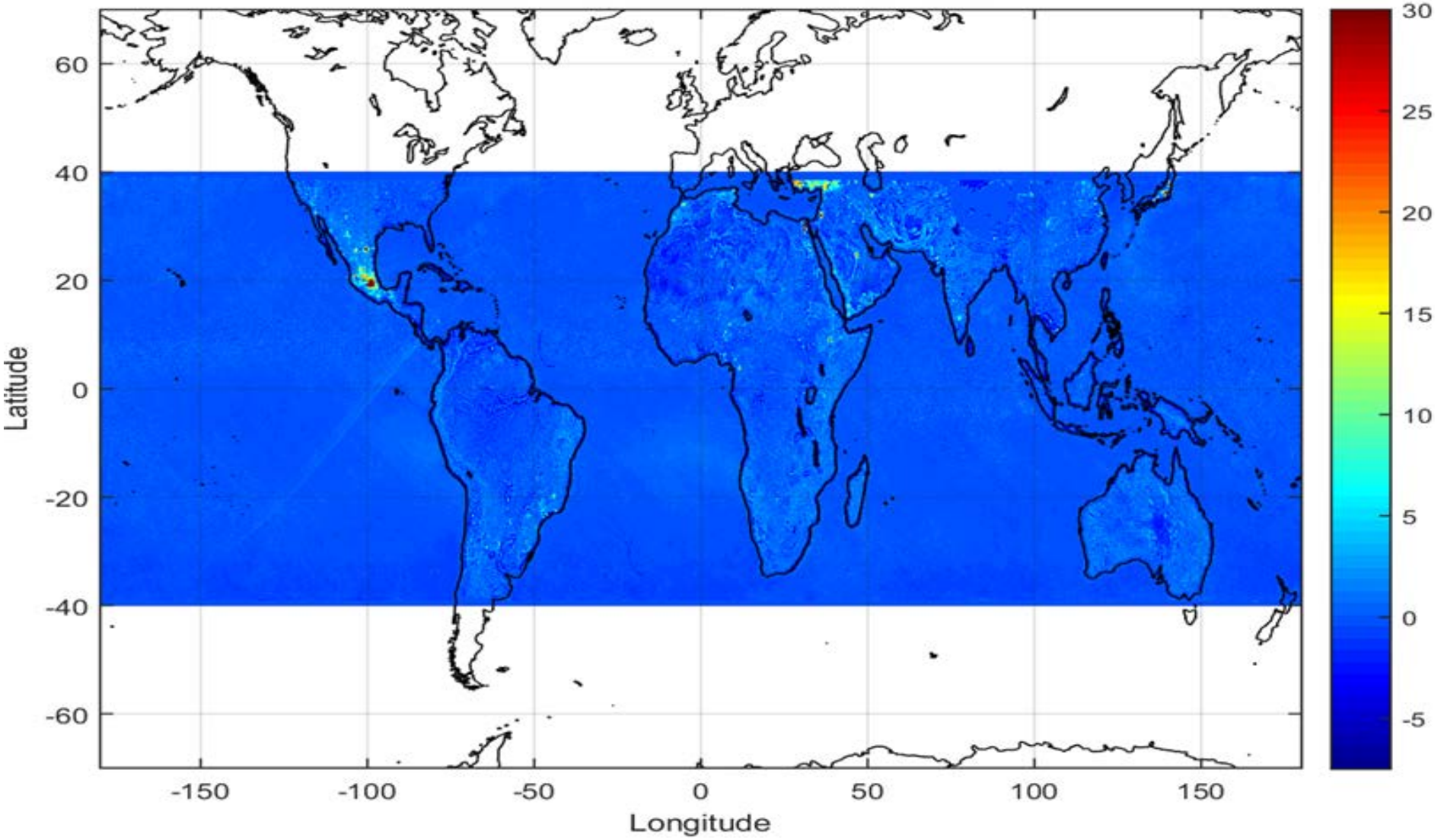
AMSR2 RFI October 2014 10.65 GHz



WindSat RFI October 2014 10.7 GHz



TMI RFI October 2014 10.65 GHz



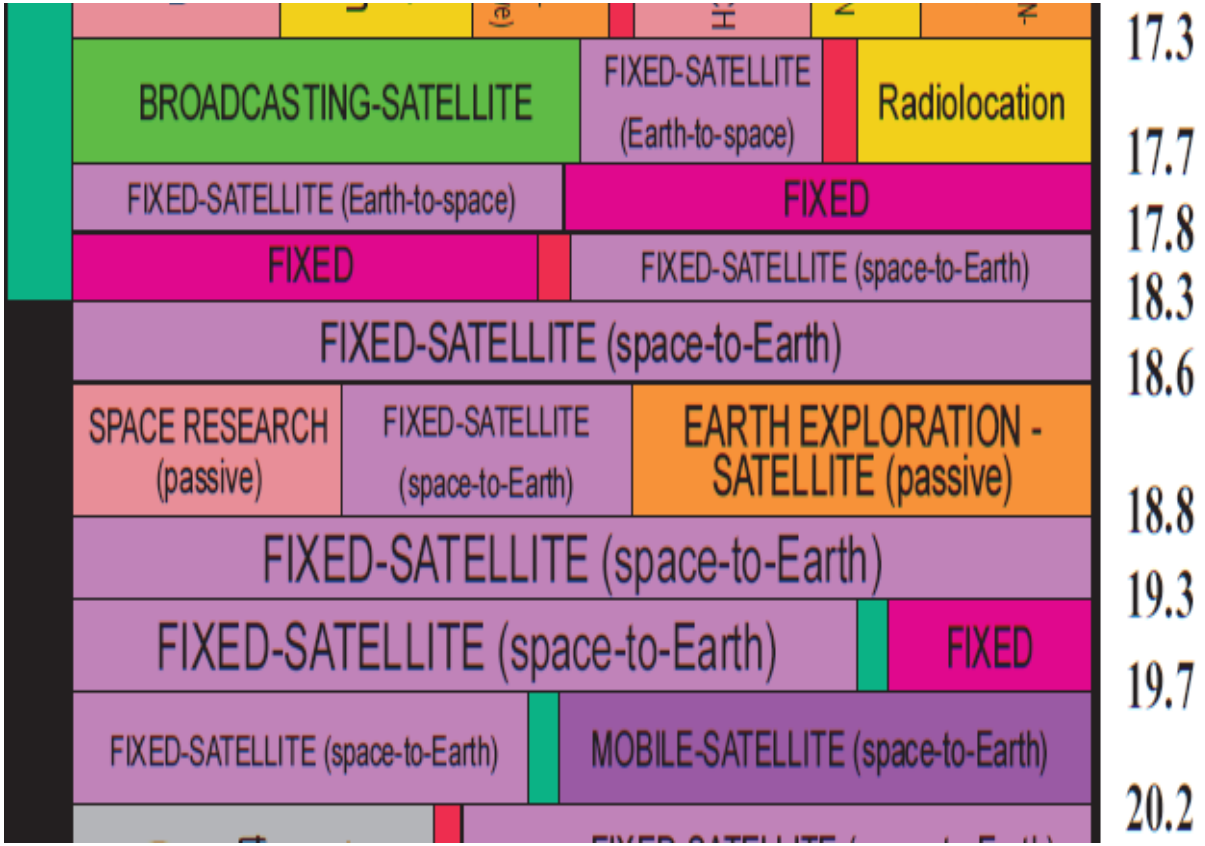
18 GHZ RFI

Radiometer Bands 18-19 GHz

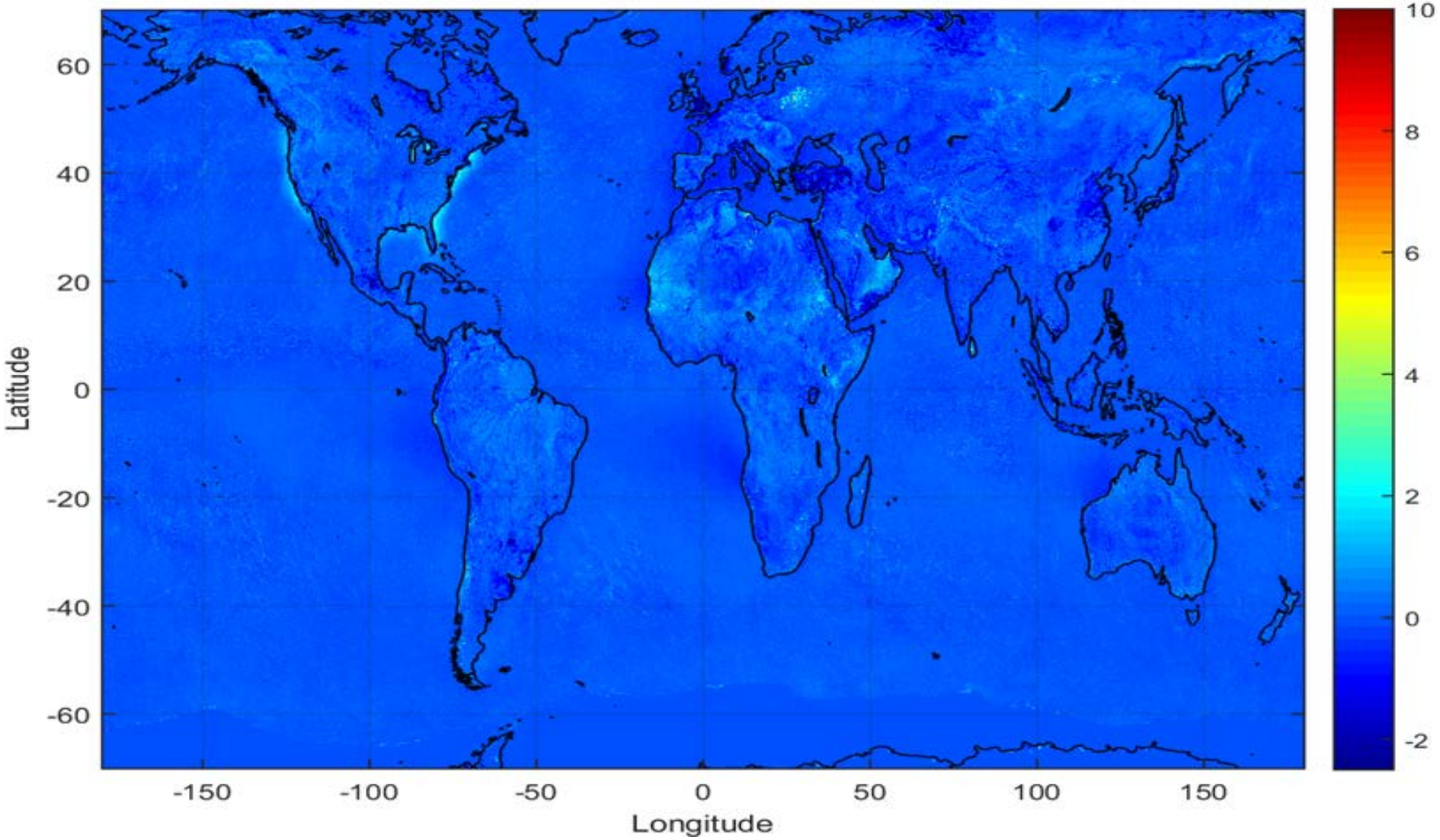
WindSat

GMI, AMSR2

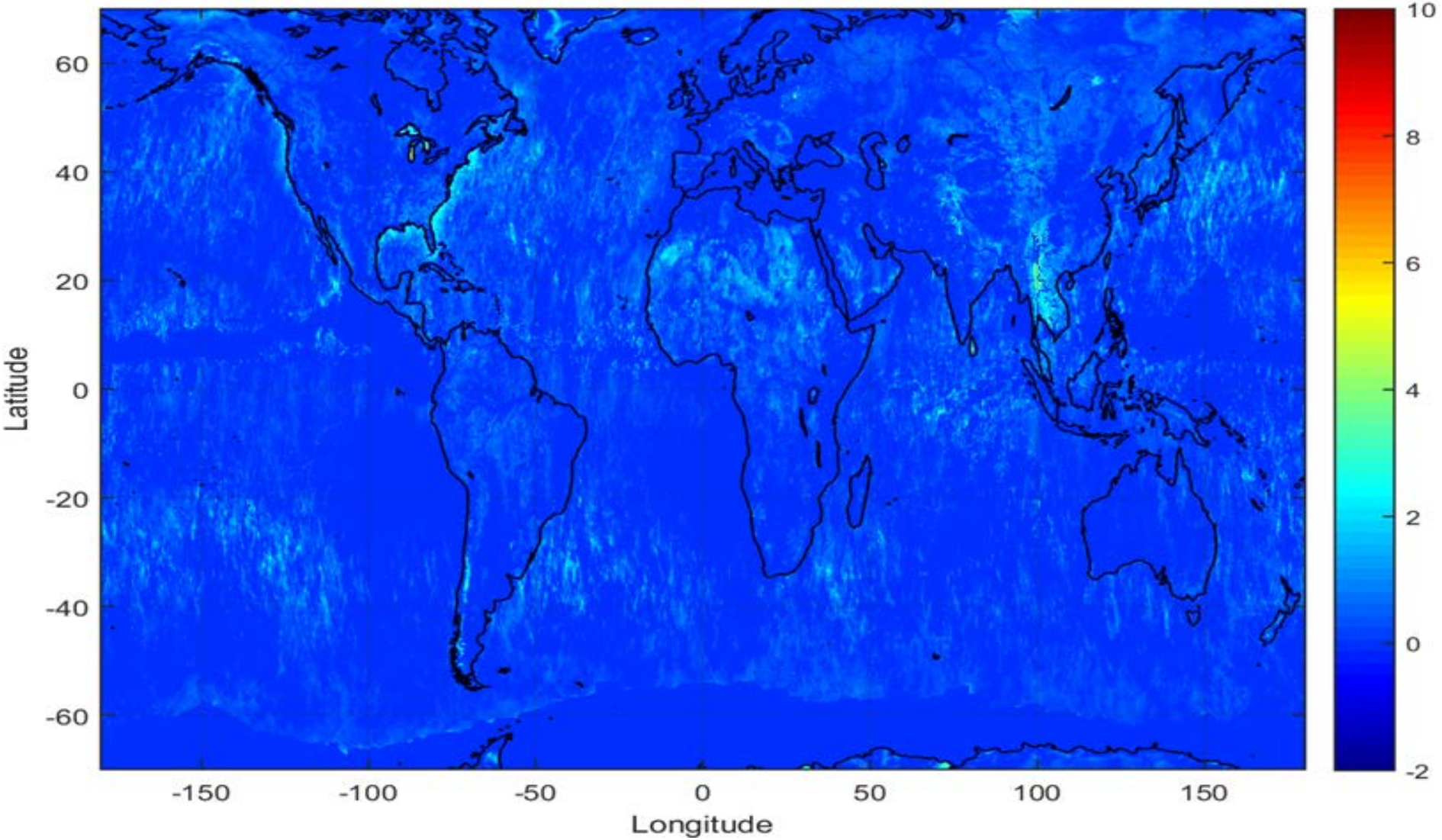
TMI, SSMIS



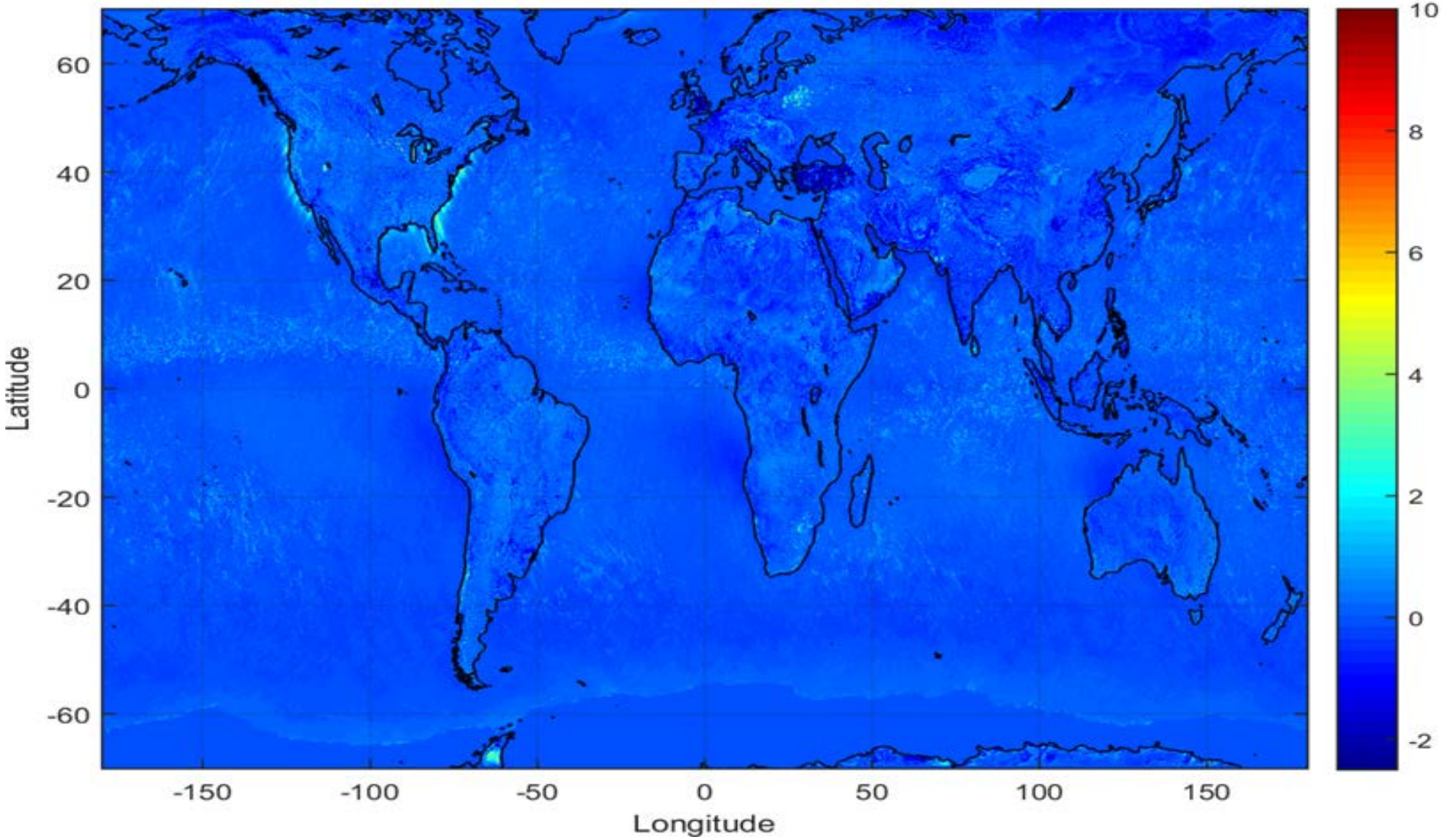
AMSR2 RFI October 2014 18.7 GHz



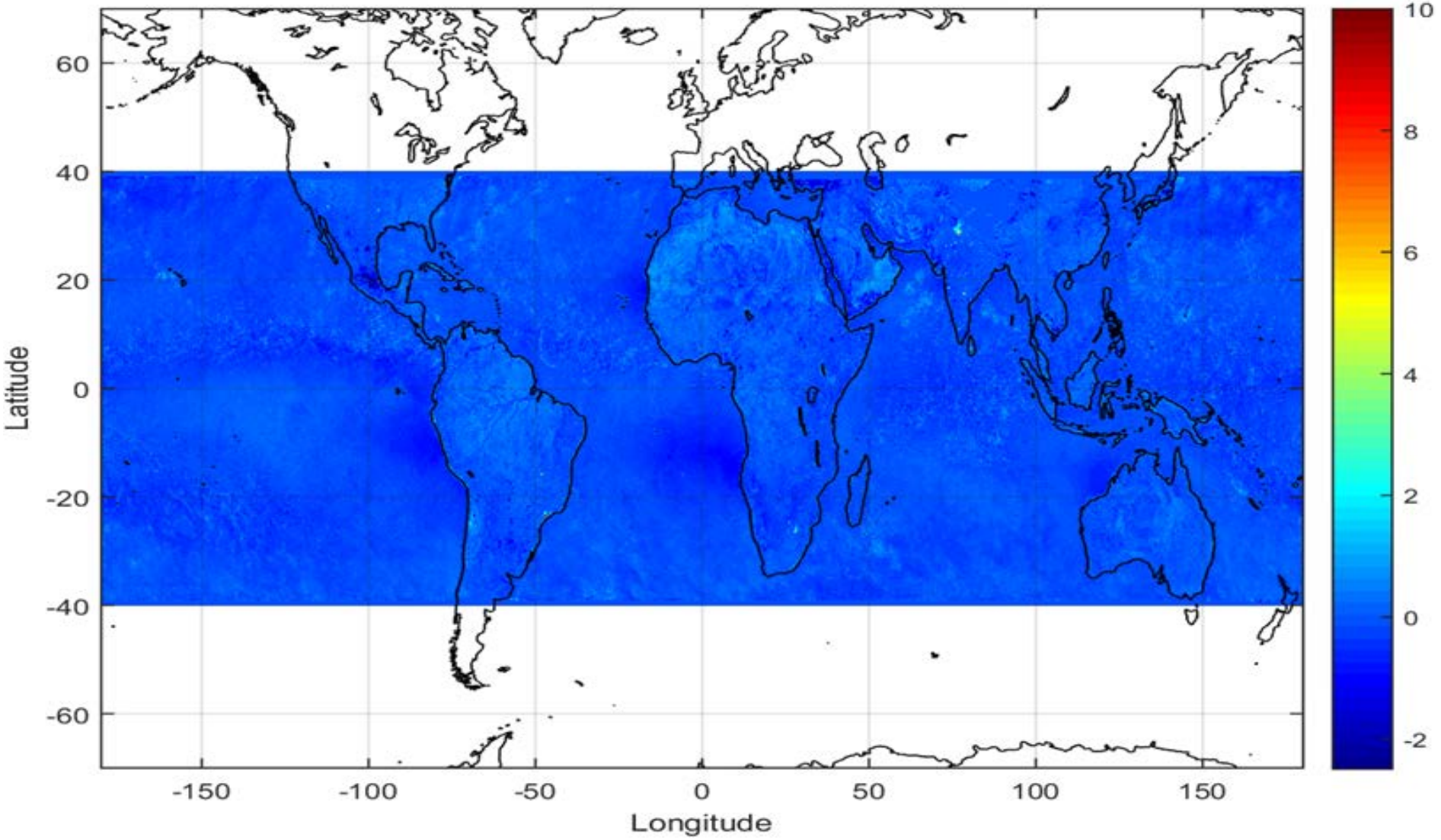
WindSat RFI October 2014 18.7 GHz



GMI RFI October 2014 18.7 GHz



TMI RFI October 2014 19.35 GHz



TMI 10 GHz RFI Trend

17 Year Trend

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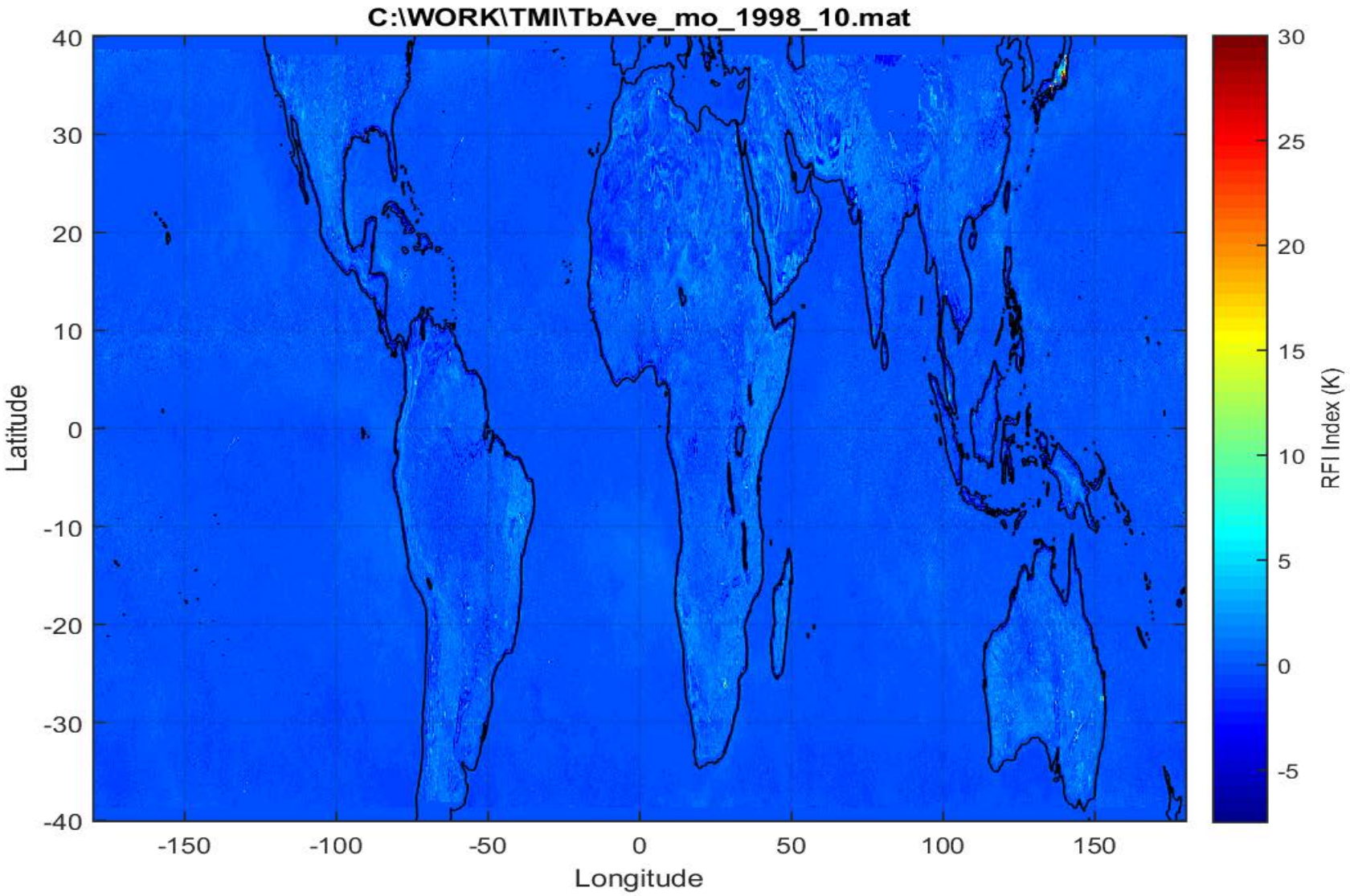
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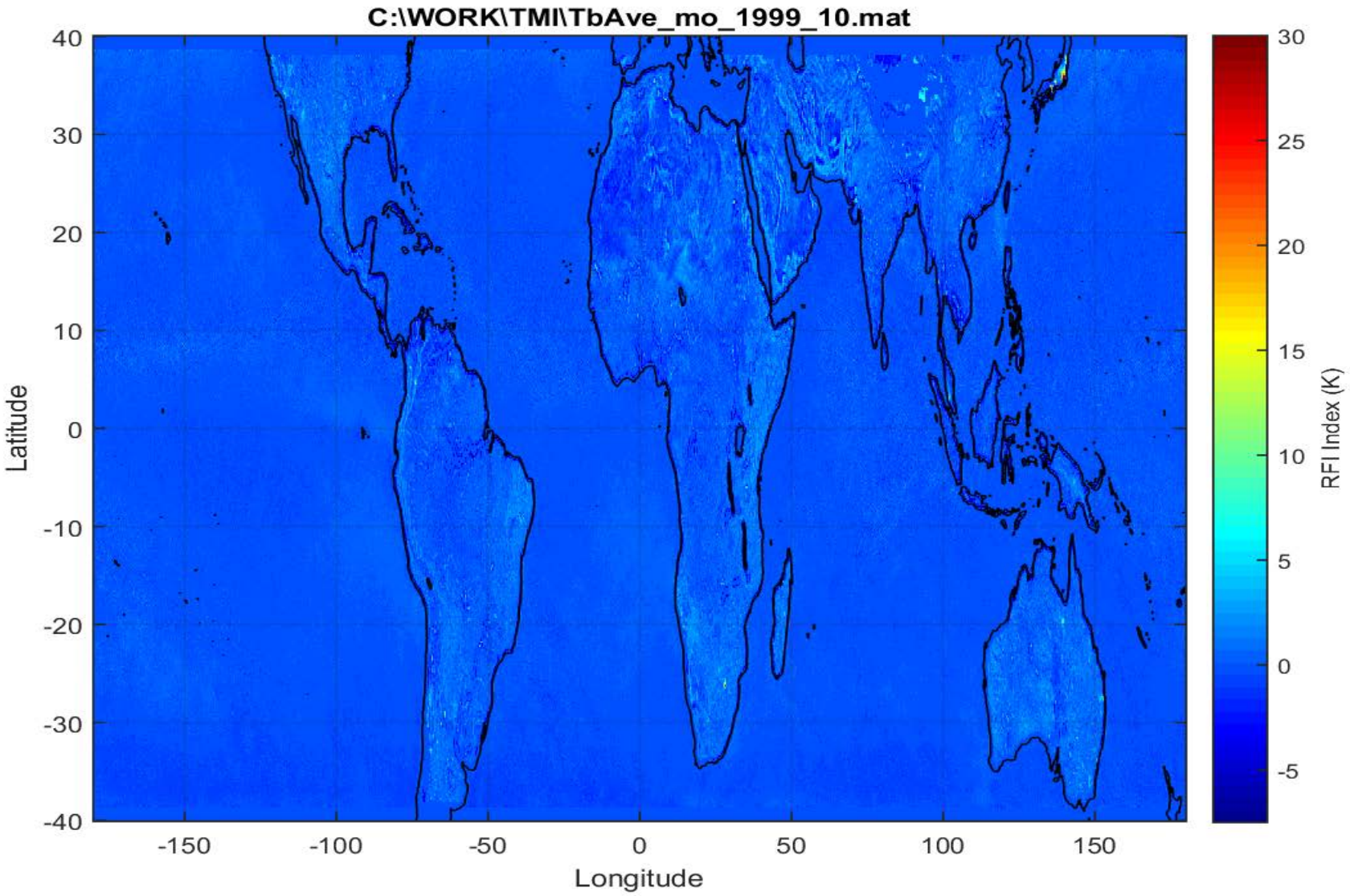
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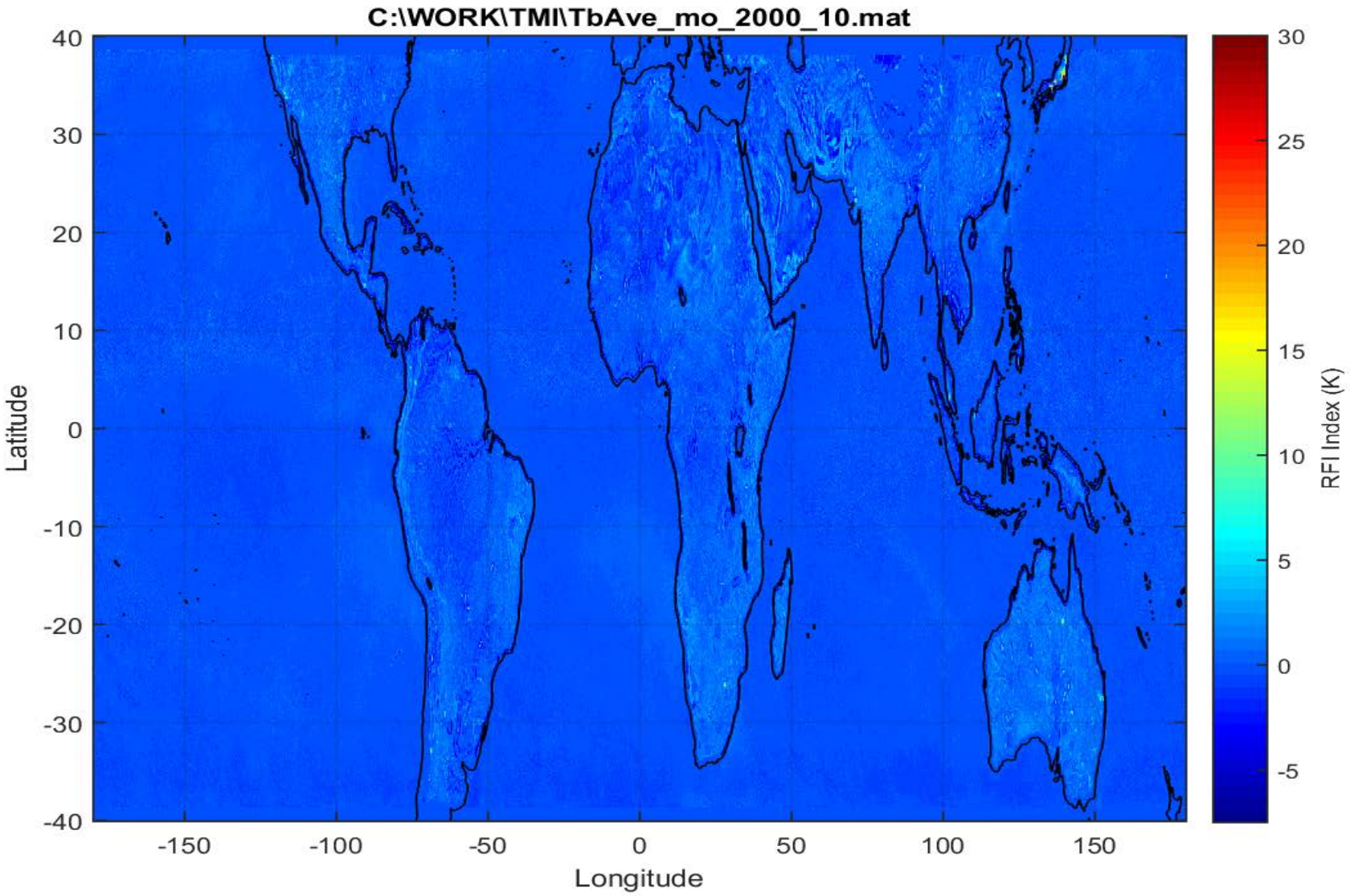
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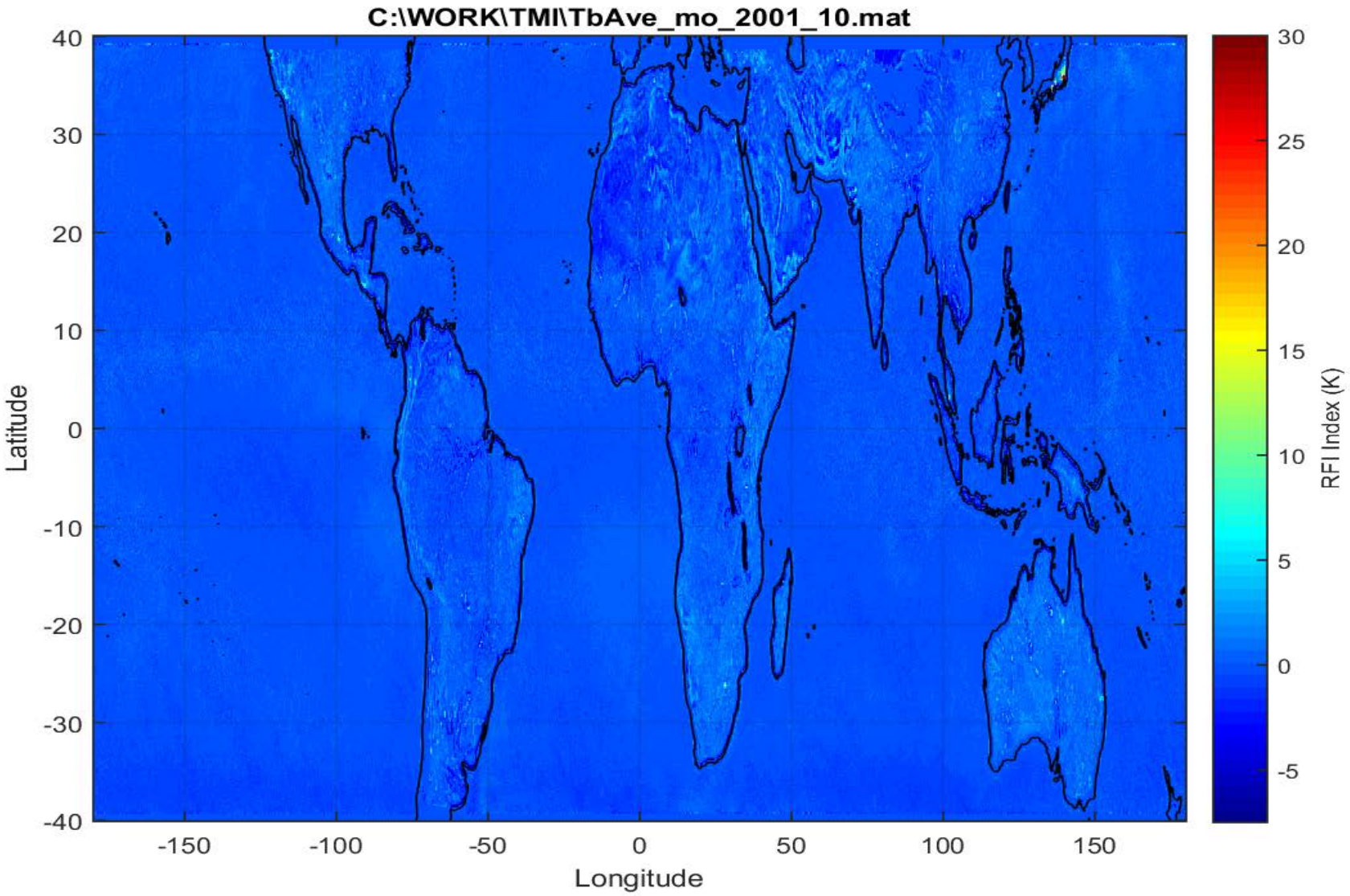
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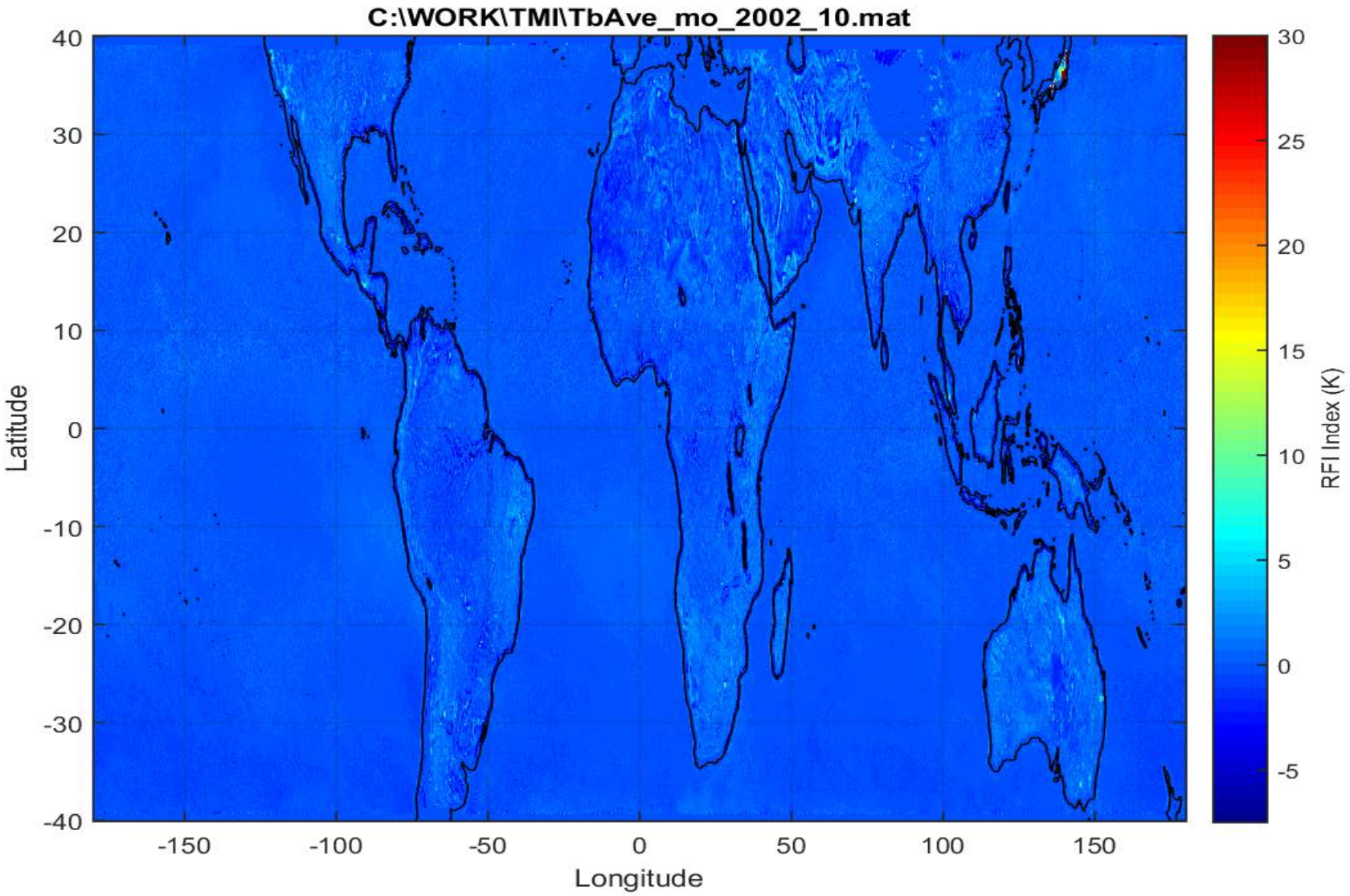
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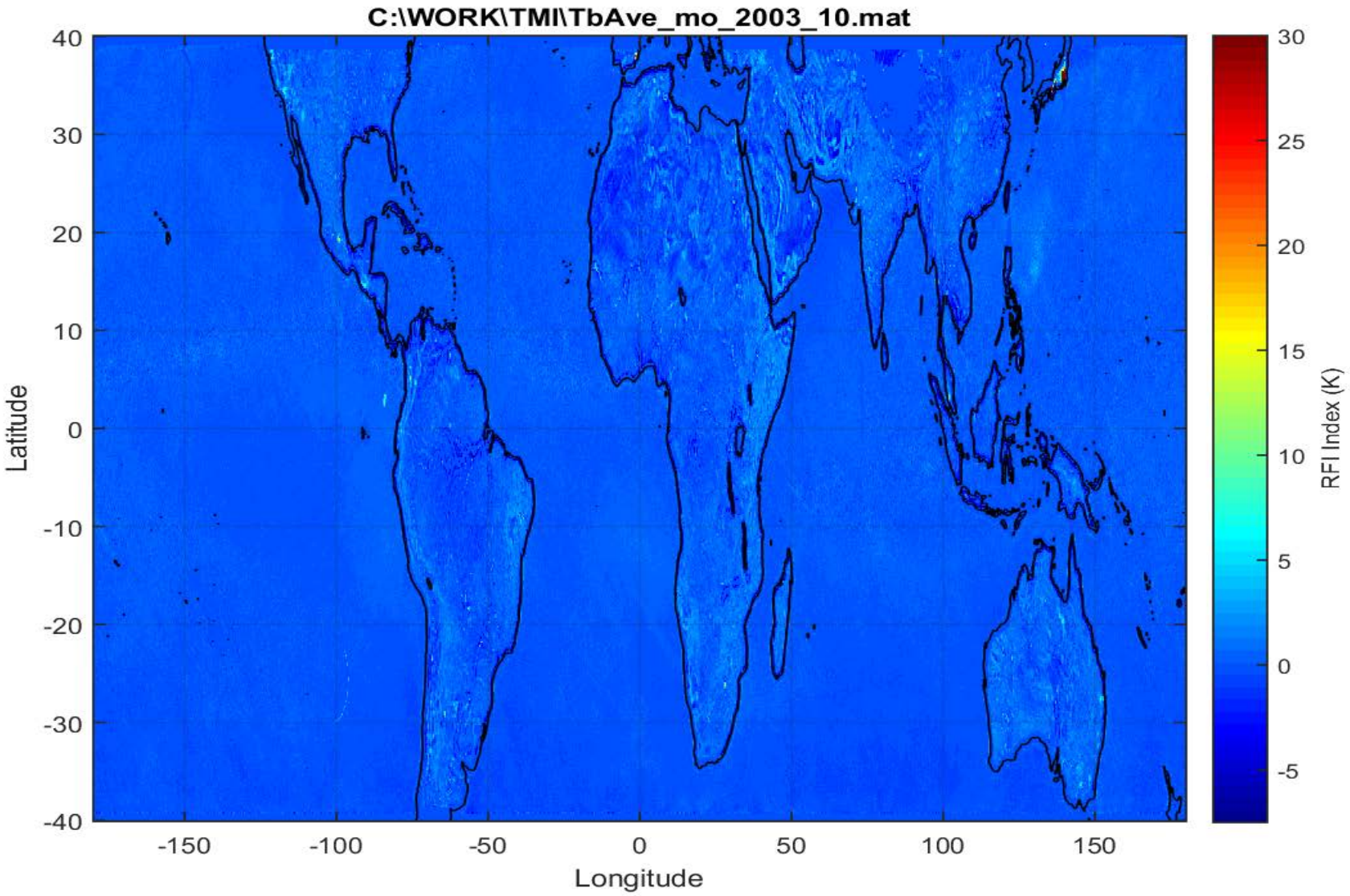
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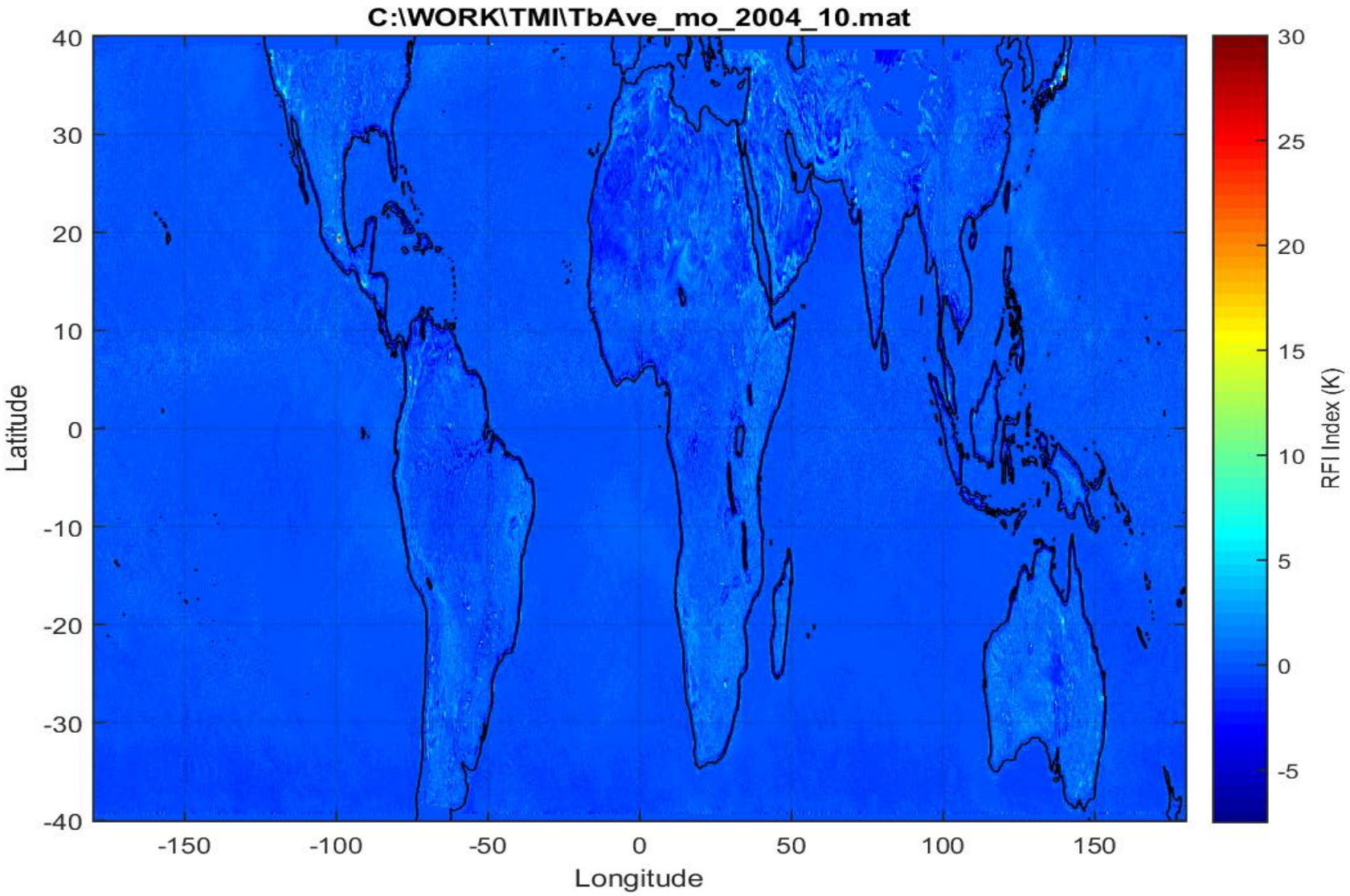
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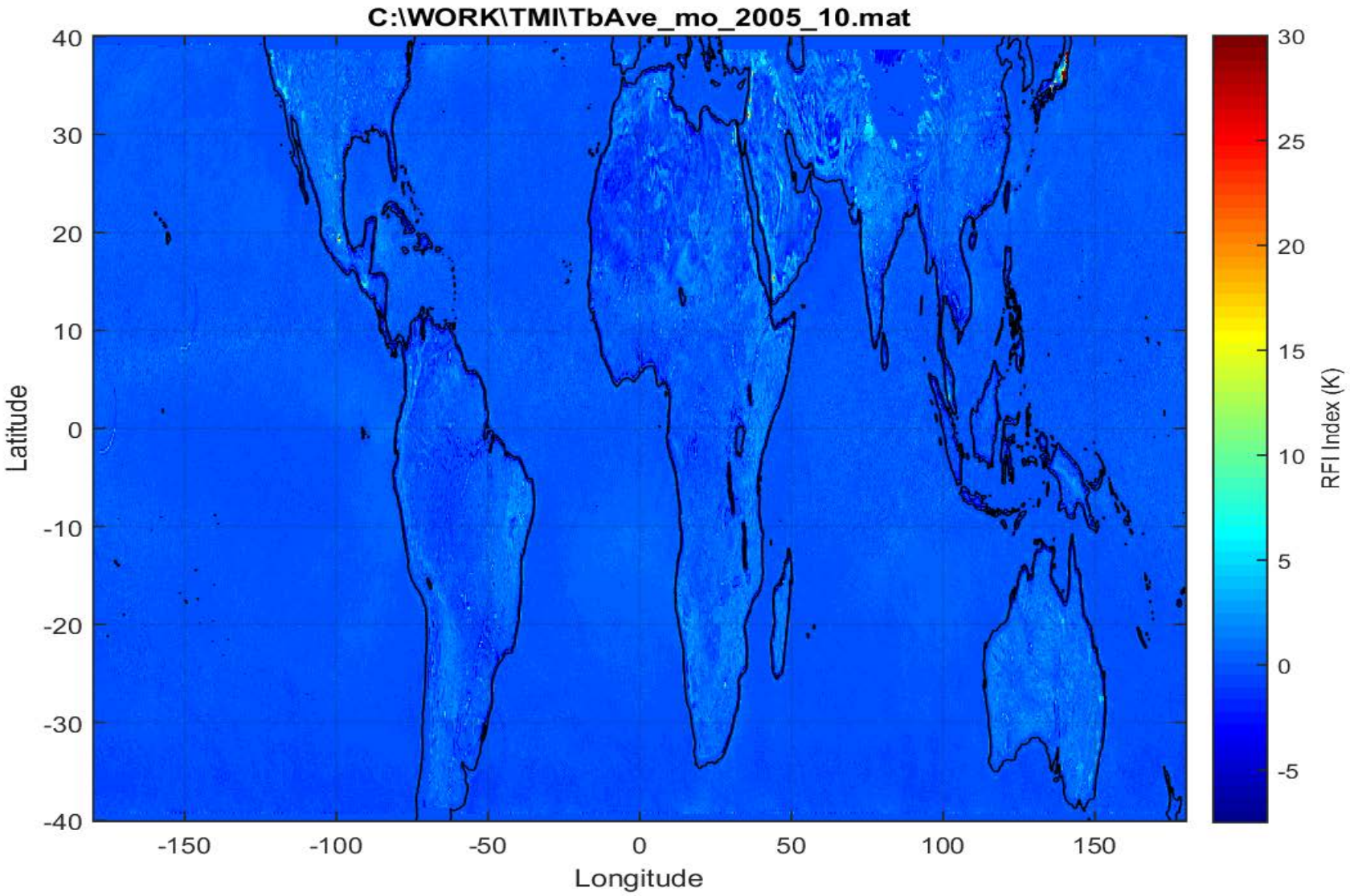
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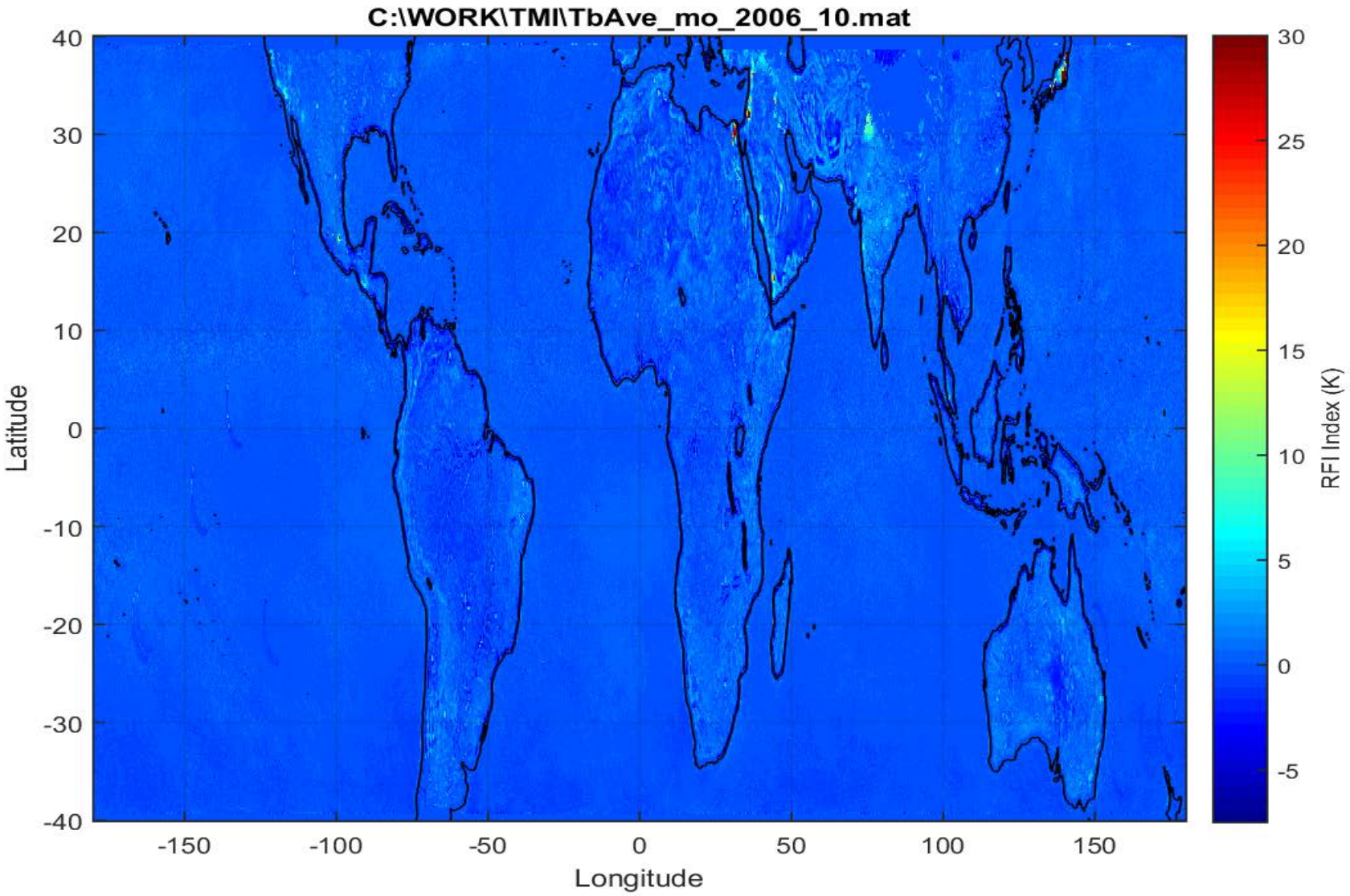
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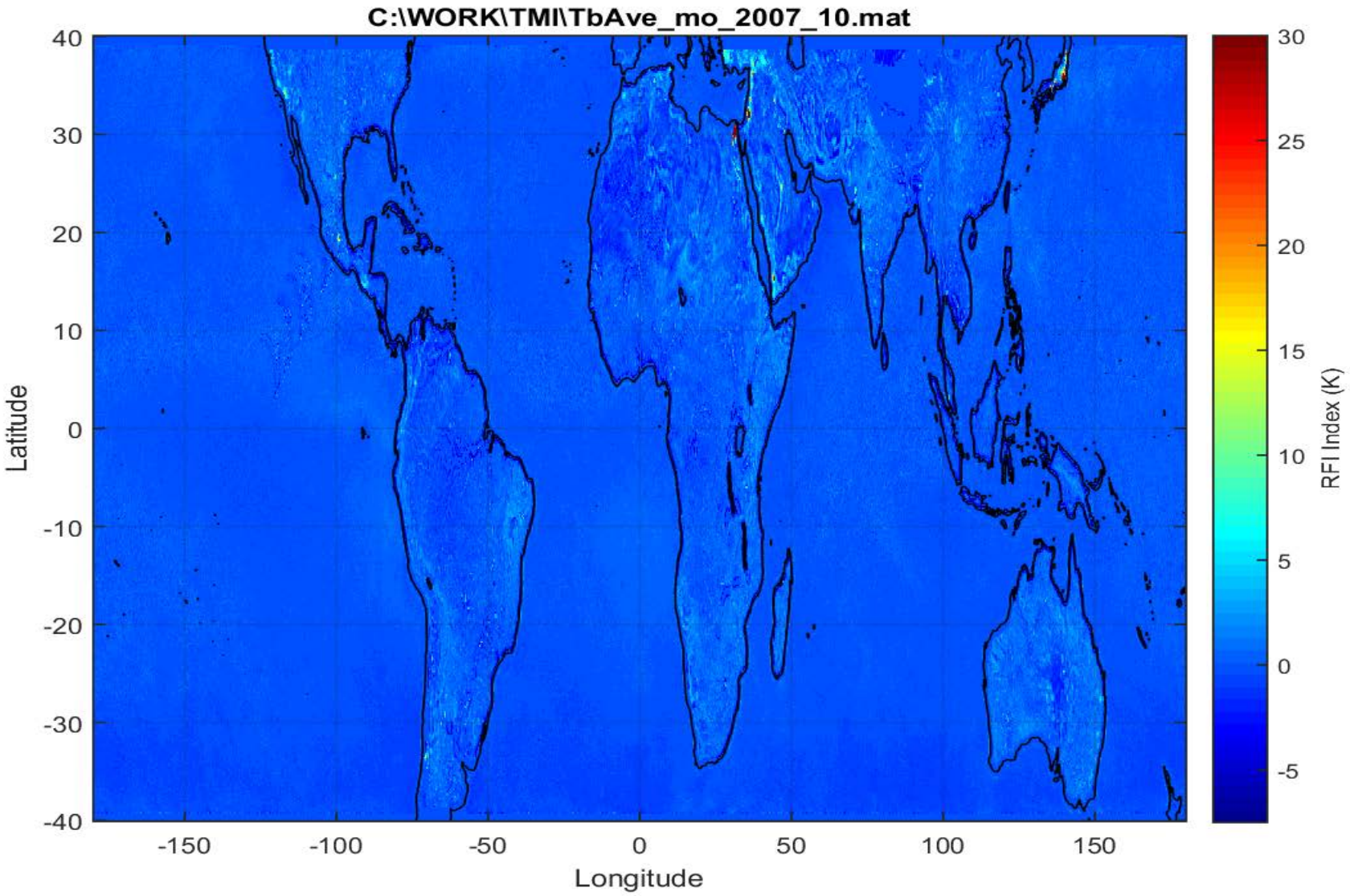
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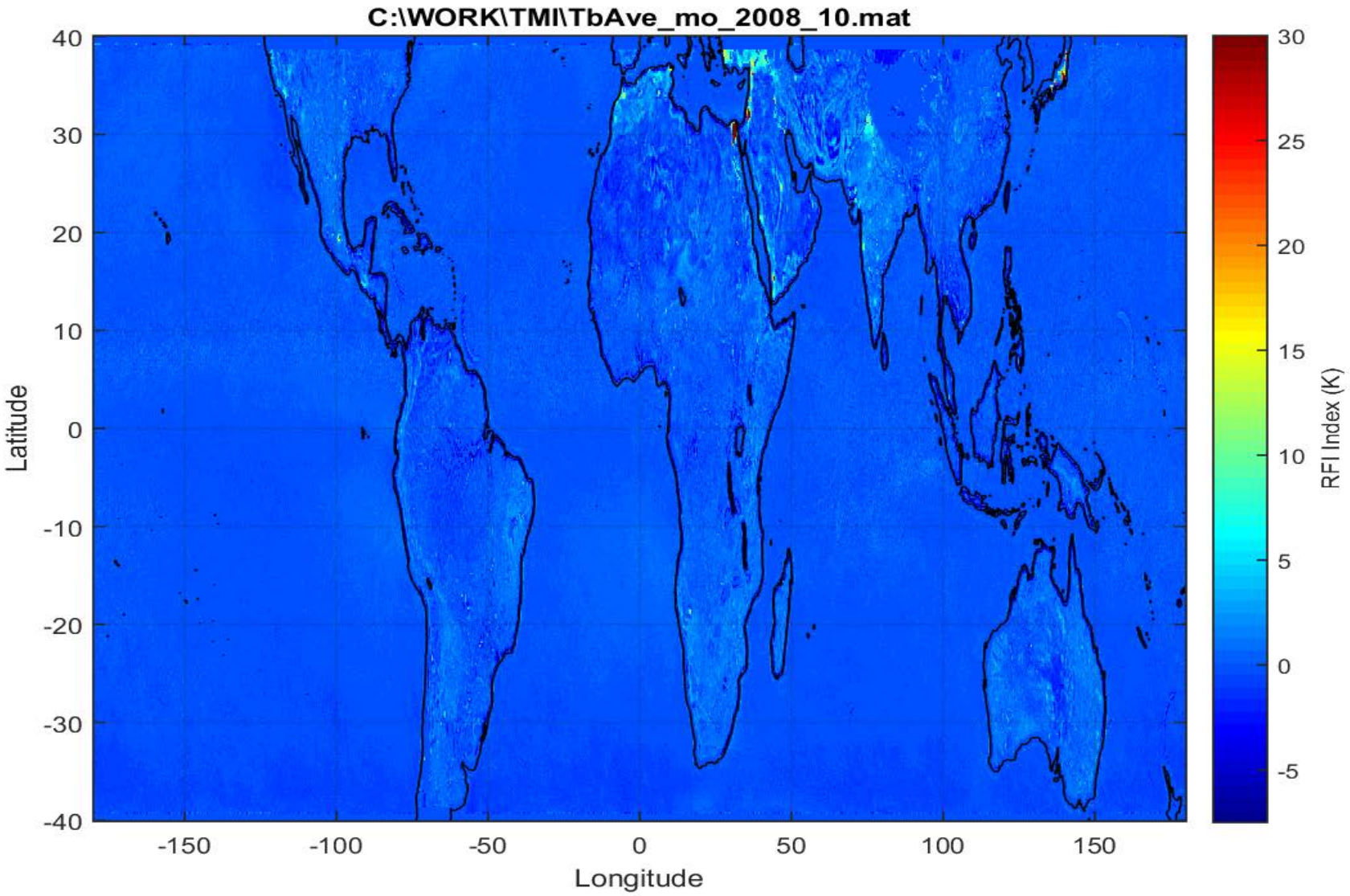
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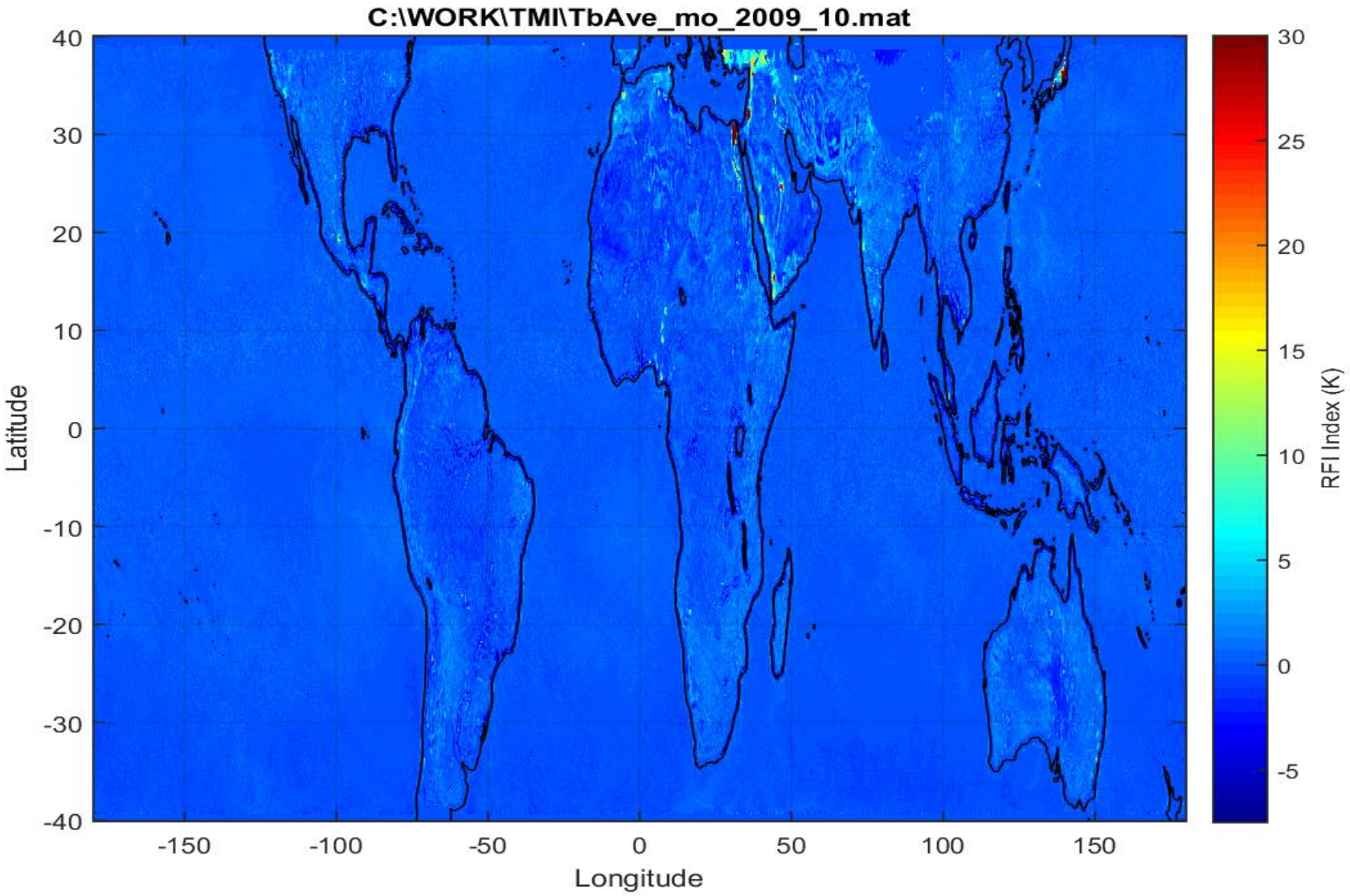
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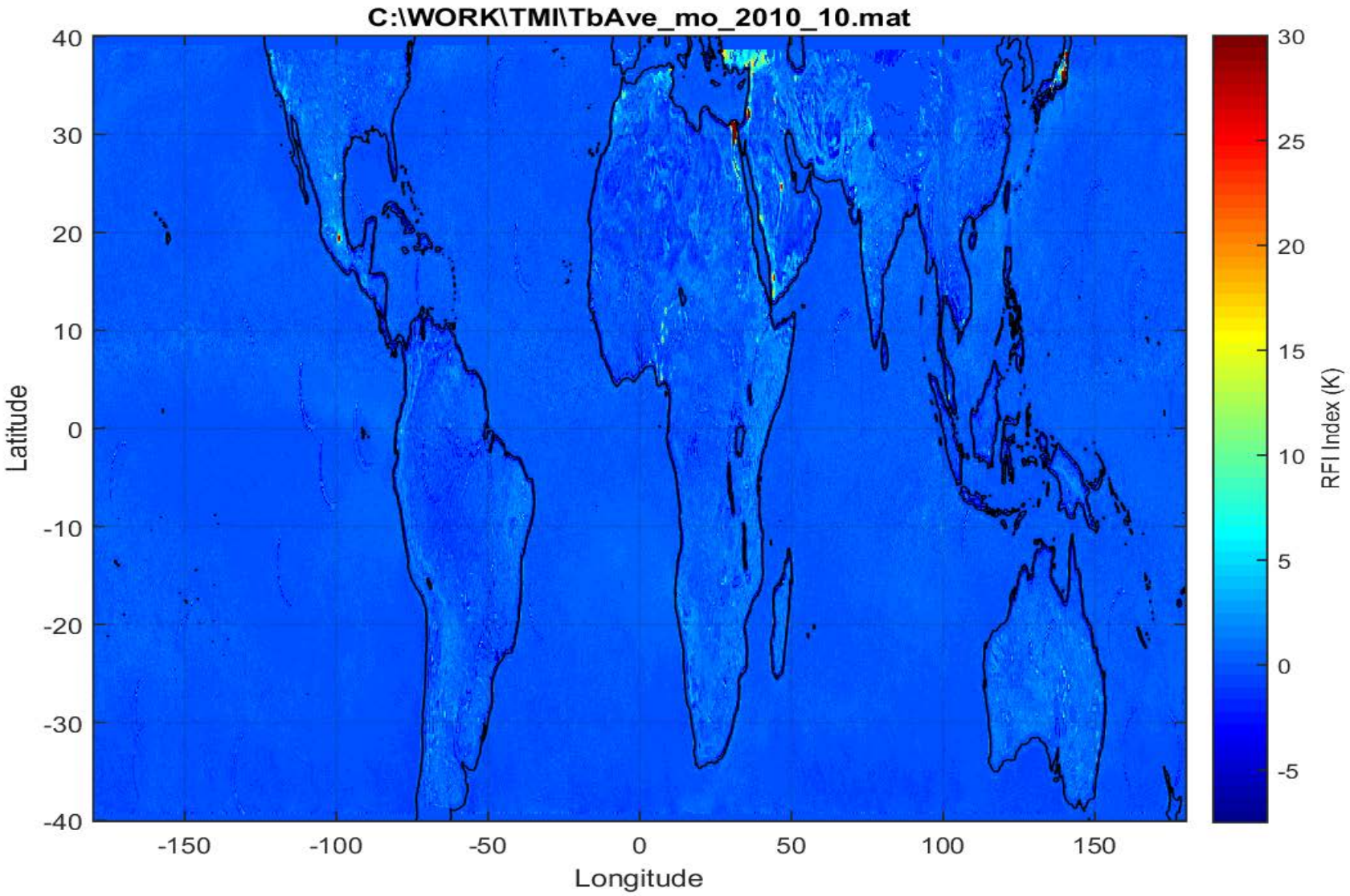
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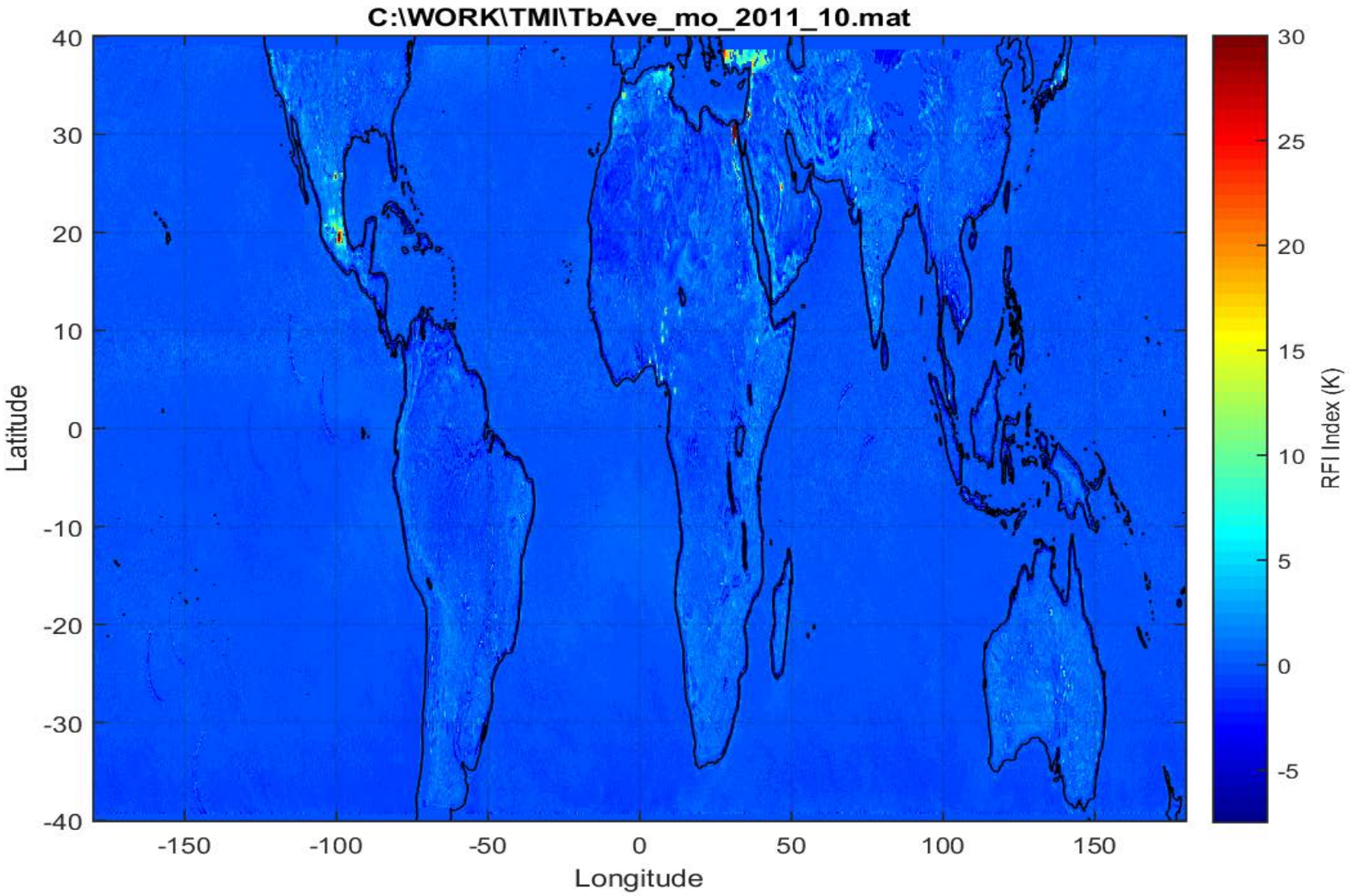
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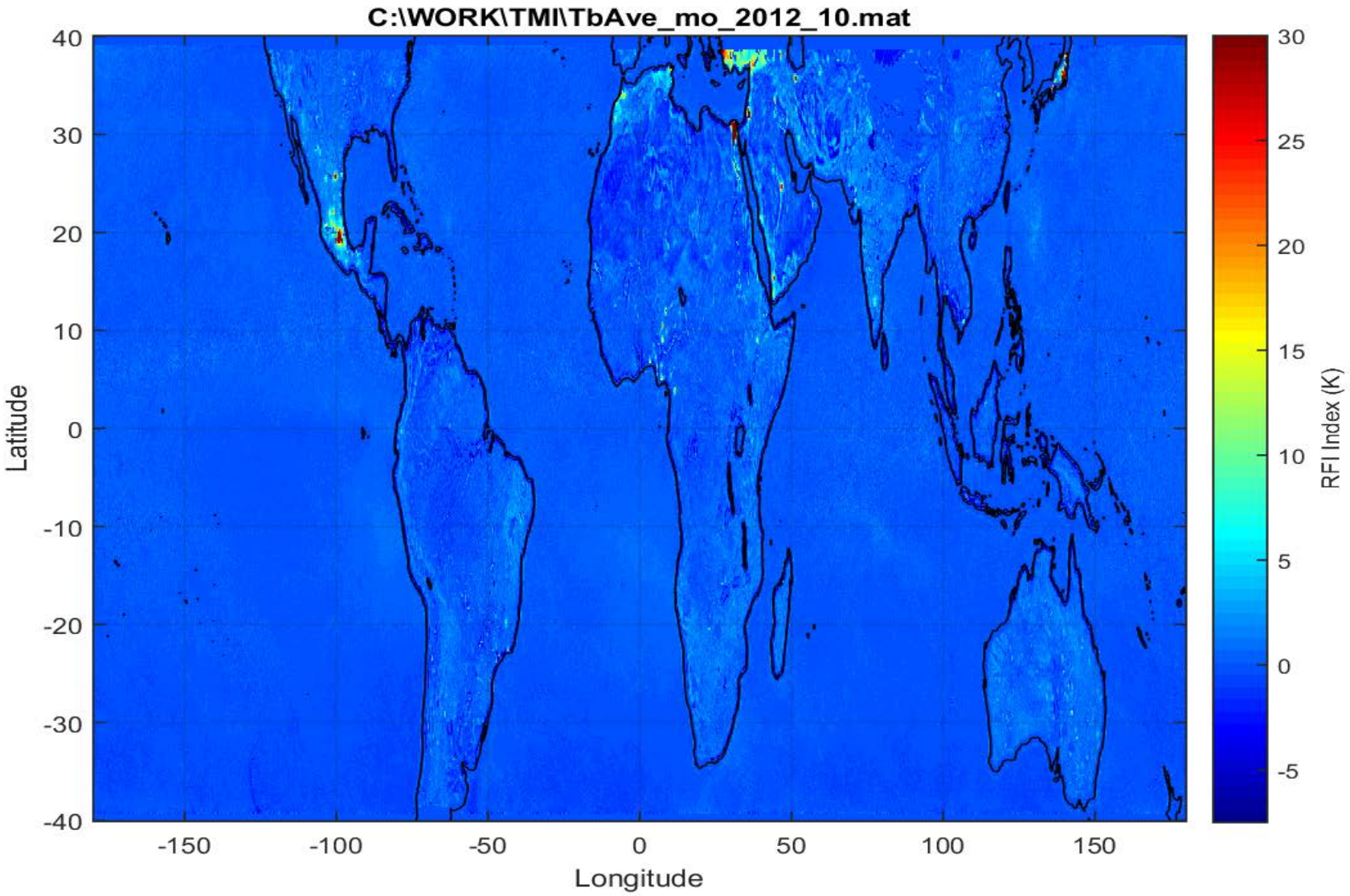
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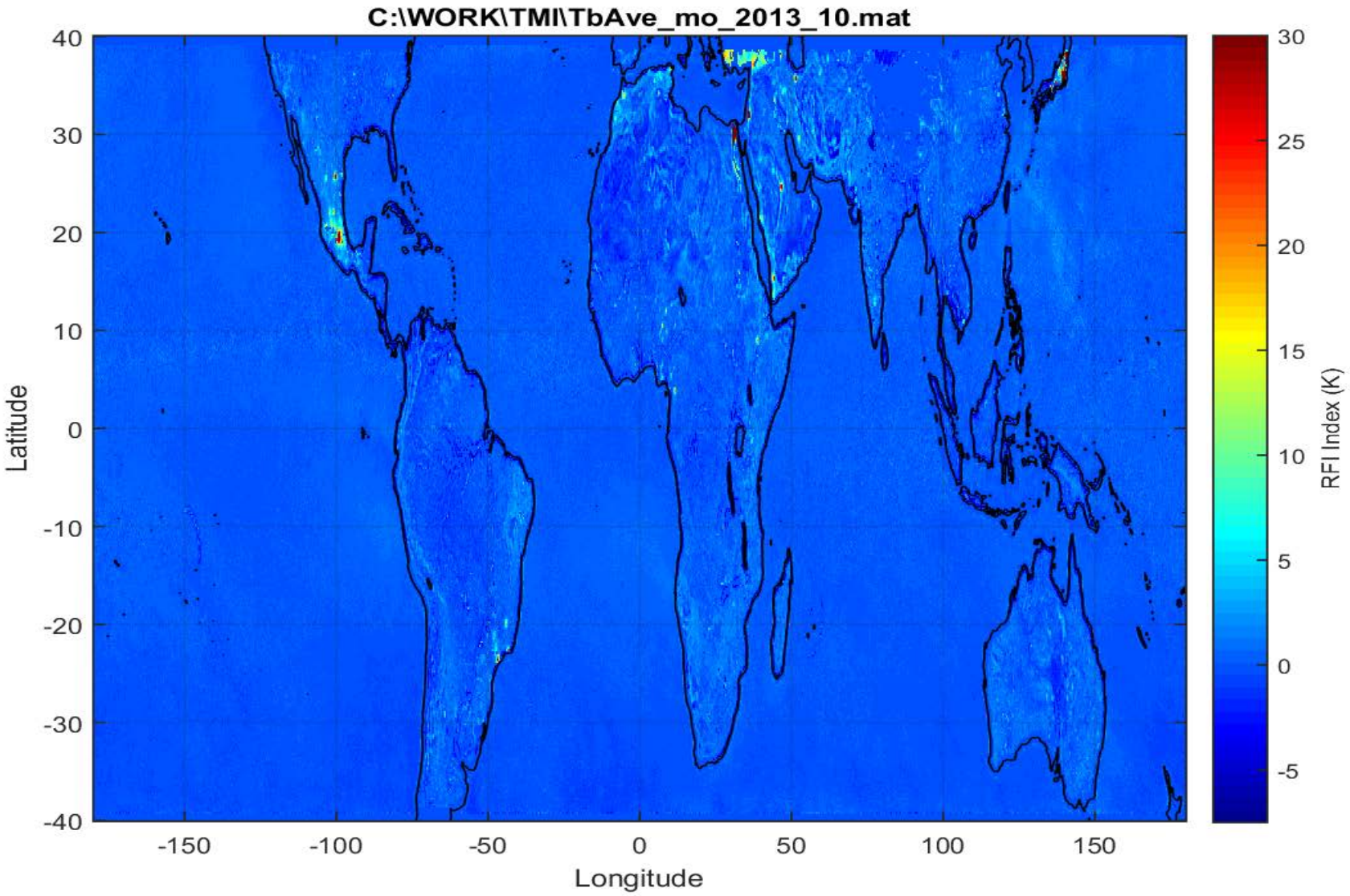
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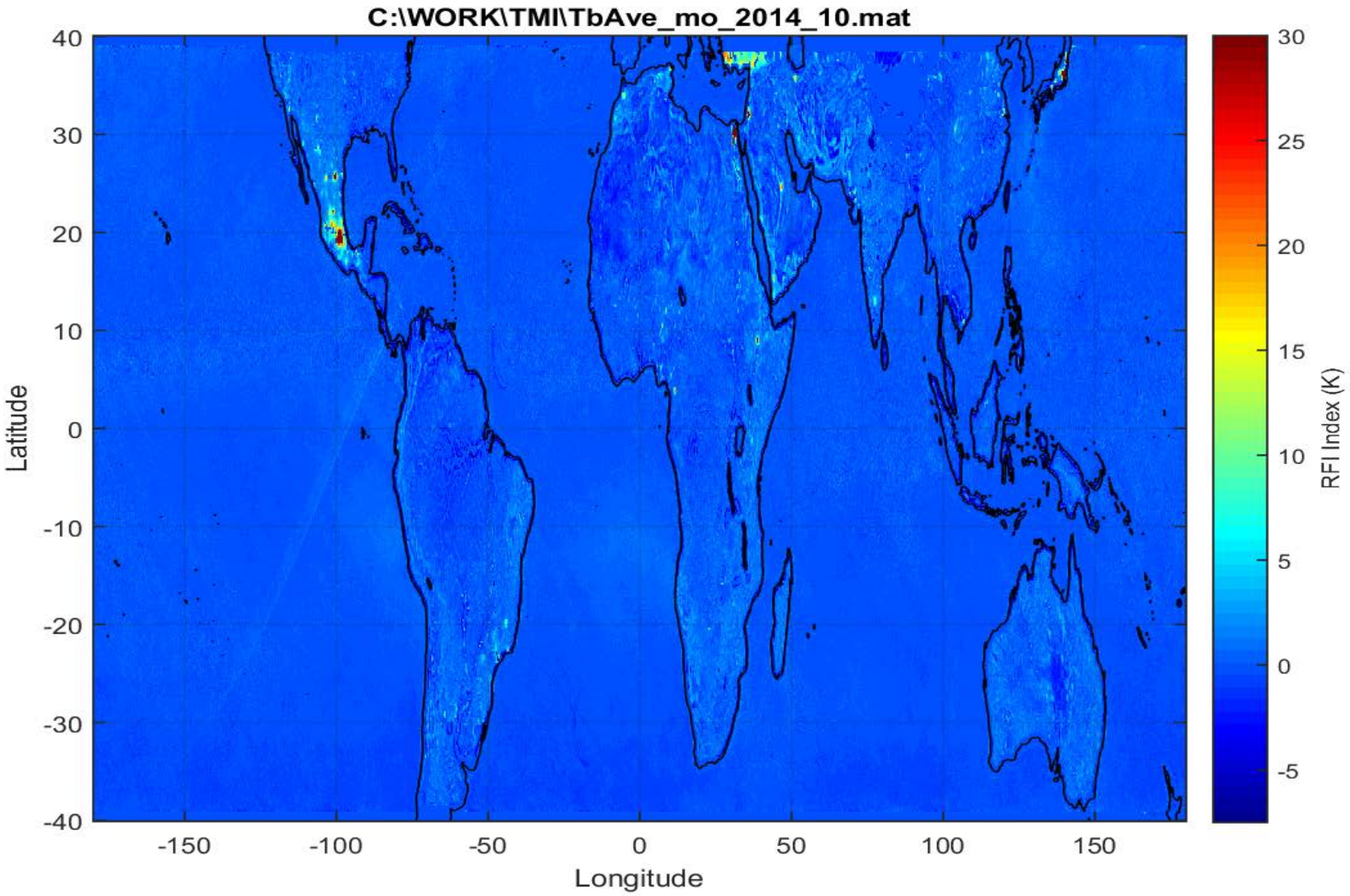
2014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Conclusions

- RFI at 10 GHz has been increasing over the last 2 decades
- Wider bandwidths (like WindSat), outside of the 10.6 to 10.7 GHz allocated band, don’t provide substantial RFI rejection over land
- The major advantage of remaining within the allocated band at 10.6 to 10.7 GHz is the reduction in reflected RFI around Europe
- RFI at 19.3 GHz doesn’t exhibit the reflections around the US that are observed within the allocated band at 18.6-18.8 Ghz.